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CONSTRUCTION REPORT FOR ARIZONA'S SHRP SPS-4 EXPERIMENT

Construction Report

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in cooperation with
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Federal Highway Administration

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16. Abstract

Nine joint sealants and five joint configurations were used on a newly constructed jointed plain concrete pavement (JPCP) along SR-360 (Superstition Freeway) in Mesa, Arizona. Twenty-four experimental transverse joint sections containing 25 to 38 joints in each section were used to evaluate sealed and unsealed joints.

Critical joint dimensions were obtained during construction on the transverse joints. Deflections at joints and at midslab between joints were measured by use of a Falling Weight Deflectometer (FWD).

The primary saw cut depth was generally less than the specified amount of one-third of the slab thickness. The majority of the measured saw cut widths were within the specified tolerances. Joint sealant depths were near the maximum for backer rods and for the tops of joints sealant depths. This resulted in shape factors often less than 1.0.

Load Transfer Efficiency (LTE) calculated from FWD data generally indicated full load transfer across joints. Uncracked joints generally demonstrated higher LTE than cracked joints.

This report consists of Volumes 1 and 2. Volume 1 contains the report, and Volume 2 contains the Appendices.

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SI* (MODERN METRIC) CONVERSION FACTORS

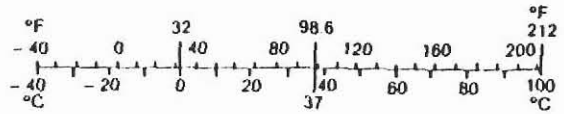
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimetres	mm
ft	feet	0.305	*metres*	*m*
yd	*yards*	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.093	*metres squared*	m^2
yd^2	square yards	0.836	metres squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	*kilometres squared*	km^2
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.028	metres cubed	m^3
yd^3	cubic yards	0.765	metres cubed	m^3
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celcius temperature	°C

NOTE: Volumes greater than 1000 L shall be shown in m^3.

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	*millimetres*	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	*kilometres*	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometres *squared*	0.386	square miles	mi^2
VOLUME				
mL	millilitres	0.034	*fluid ounces*	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celcius temperature	1.8C + 32	Fahrenheit *temperature*	°F



* SI is the symbol for the International System of Measurement

(Revised April 1989)

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INTRODUCTION

Problem Statement

The cost effectiveness, performance and maintenance of joint sealants is important to local, state and federal agencies. Currently, research using various joint sealants is being conducted on new as well as existing pavements. The Strategic Highway Research Program (SHRP) has acknowledged the need for research in this area. SHRP SPS-4 (Maintenance Effectiveness Study of Concrete Pavements) has been developed to address problems with joint sealing.

The purpose of this Arizona Department of Transportation (ADOT) research program is to develop performance data for nine joint sealants and five joint configurations over a time period of ten years. The information obtained from this research project will be useful to ADOT and other state and federal agencies that construct portland cement concrete (PCC) pavements in a dry-nonfreeze climatic region.

Project Objectives

This research project was designed to evaluate nine joint sealants and five joint configurations over an extended period of time on a portion of recently constructed jointed plain concrete pavement (JPCP) along SR360 in Mesa, Arizona. Furthermore, the intent of this research is to relate these joint sealants to the cost of installation and load transfer properties determined by falling weight deflectometer (FWD) data. The following objectives were established for this project:

- Compare the performance between sealed and unsealed transverse joints. This is a SHRP SPS-4 experiment.

- Establish the cost effectiveness of the various types of joint sealants used in this experimental project. This information will be valuable not only for determining life cycle costs for new concrete pavement but also for establishing maintenance and rehabilitation strategies for existing concrete pavements as far as joint sealants are concerned.

- Develop relationships between joint evaluation criteria and pavement performance. This would include the collection of FWD data at transverse joint locations.

- Evaluate alternate joint sizes and details. Small joints provide for a quieter ride, and results in narrower joints after rehabilitation.

Project Location and Description

The project was located on a 2.15-mile segment of newly constructed PCC pavement on the Superstition Freeway (SR 360) between Power Road and Ellsworth Road in Mesa, Arizona. This segment of roadway was designed under ADOT Project No. F-028-1-311. The construction project location is shown in Figure 1. This project is approximately 25 miles east of Phoenix in central Arizona. The experimental portion of the project is located in the east part of Mesa, Arizona at a ground elevation varying from 1365 to 1465 ft. Mean annual precipitation is approximately 7 inches. Mean daily temperature is 75°F with yearly extremes from 30°F to 115°F.

The new roadway consists of a 6 lane divided highway section, with inside and outside shoulders, interchange ramps and overpass roadways. Mainline pavement lanes are 12 ft wide PCC with 11 ft wide inside concrete shoulders and 8.5 to 10 ft wide outside concrete shoulders. The pavement was designed for 2,891,700, 18 kip Equivalent Single Axle Loads (ESAL), and a 20 year design life.

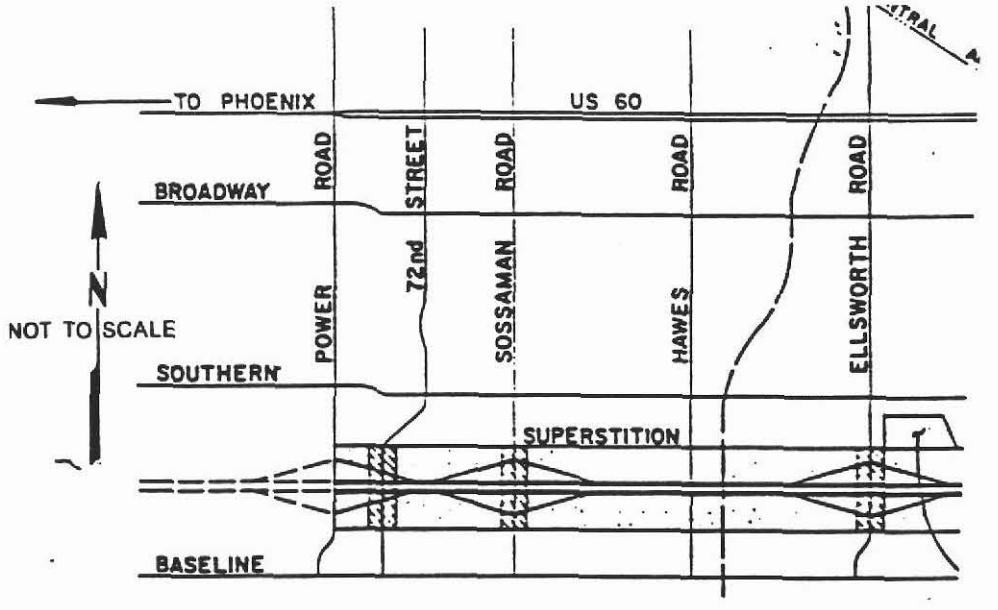

Figure 1 - Construction Project Location

Surface and Subsurface Soil Conditions

The predominant soils for this roadway alignment can be described as silty sand to sandy silt. These soils have been classified in accordance with the Unified Soil Classification System as SM to ML soil types.

The silty sand to sandy silt extends from the surface to the full depth of exploration (20 ft). Occasional layers of sandy gravel and gravelly sand are encountered below a depth of 10 ft.

In general the soils to a depth of 10 feet are medium dense to dense. Below a depth of 10 feet the soils are very dense as indicated by standard penetration test values.

The pavement section consisted of 13 inch thick jointed plain concrete pavement on 4 inches of compacted aggregate base placed on a compacted subgrade. The transverse joint spacing plan was established at staggered intervals of 13, 15, 17, 15 ft, and then continually repeated. The joints were skewed 2 on 12. The construction joints were not doweled.

Two experimental test zones were established on this project to evaluate nine different joint sealants. Experimental Zone No. 1 (Test Section Nos. 1 - 12) commences at Station 957+75 and extends to Station 1005+00. Experimental Zone No. 2 (Test Section Nos. 13 - 24) begins at Station 892+50 and extends to Station 939+25. The test sections were located in the eastbound travel lane, and are bounded by Power Road on the west and Ellsworth Road on the east.

Contract History

In 1990, the Arizona Department of Transportation awarded this project (Contract # F-028-1-514) to Ball, Ball and Brosamer, Inc. of Danville, California. The cost of the installation of the nine transverse joint sealants in the 24 test sections was included in Change Order No. 19. Joint sawing and sealant installation for this project were performed by Multiple Concrete Enterprises of Layton, Utah.

EXPERIMENTAL PLAN

General

This research experiment required in excess of two miles of newly constructed PCC pavement in one direction. Each sealant was tested in a test section located in each experimental test zone. Each test section included 25 continuous transverse joints, except for one SHRP test section located within each experimental test zone. Twenty joints in each test section are to be left undisturbed throughout the performance life of the sealant. This results in 50 joints per sealant product within the experiment. Nine different sealants products were used in this experiment.

Test Sections

Figure 2 shows the layout of Experimental Zones No. 1 and No. 2. This drawing provides the experimental field plan. Each test section was approximately 375 feet in length and contains 25 joints. Two control sections (Section Nos. 3 and 17) were unsealed, and approximately 600 feet

in length. Section No. 3 was a SHRP unsealed test section. These two unsealed sections required only a primary saw cut. A secondary or reservoir cut was not required. Section No. 2 is a SHRP section and was sealed using a silicone joint sealant.

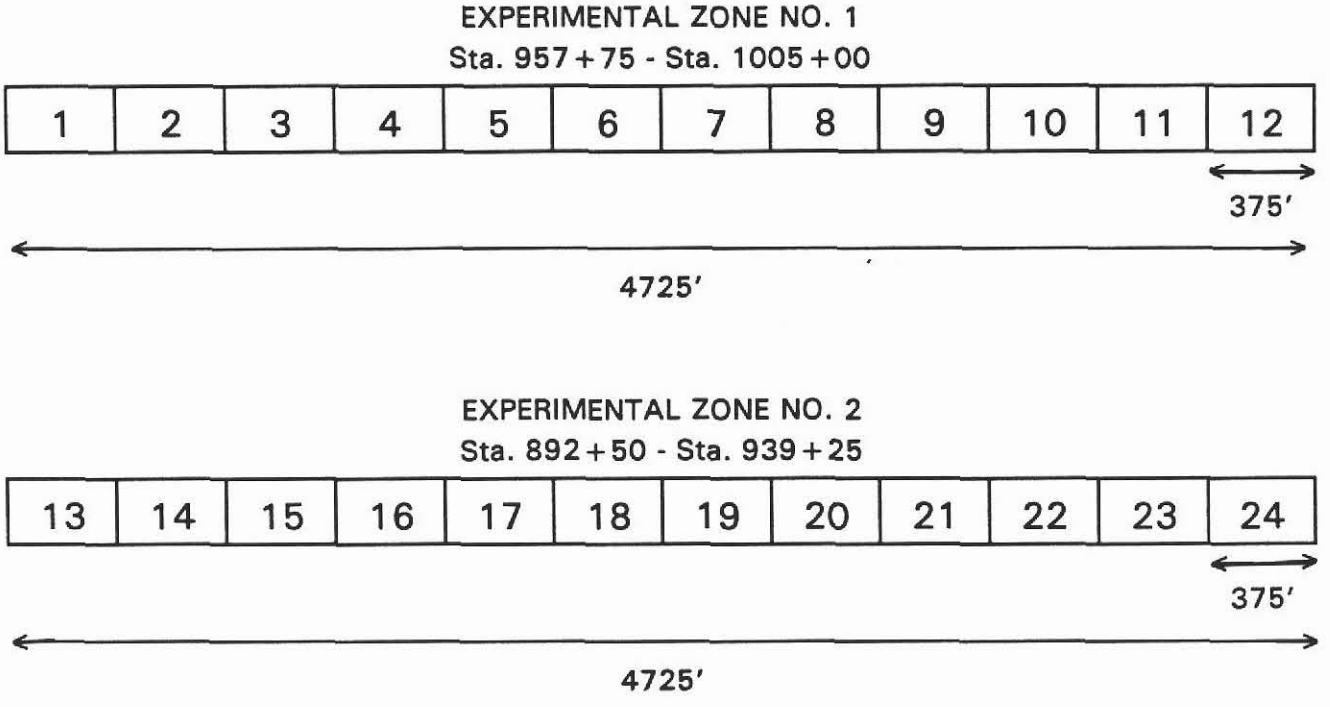

Figure 2 - Experimental Zones

Joint Sealants

Nine sealants representing four material classifications were used in this research project. These include compression seals, silicone, hot-pour, and silicone self leveling sealants. A product literature review was first conducted by Arizona Transportation Research Center (ATRC) to determine what joint sealant products were available and what sealants were currently being used in JPCP. This work was performed in conjunction with information available from ADOT and other federal and state agencies.

From the available information, nine joint sealants were recommended for use in this research project. The sealant installed at each test section along with the joint detail number is provided in Table No. 1. An Elastomer PV-687 compression seal was initially included as one of the sealants to be used for this project. Watson Bowman WB-687 and WB 812 sealants were used in lieu of the Elastomer PV-687 compression seal.

TABLE 1 - JOINT SEALANTS INSTALLED

	Test Section No.	Product Installed	Joint Detail
EXPERIMENTAL ZONE NO. 1	1	Delastic V-687 Comp. Seal	5
	2	Crafco Silicone S.L.	1
	3	Unsealed	2
	4	Dow 890 S.L.	3
	5	Watson Bowman WB-812	5
	6	Dow 888 S.L.	1
	7	Dow 888	1
	8	Crafco 444	1
	9	Dow 890 S.L.	4
	10	Mobay Baysilone S.L.	1
	11	Crafco 221	1
	12	Dow 890 S.L.	1
EXPERIMENTAL ZONE NO. 2	13	Dow 890 S.L.	4
	14	Delastic V-687 Comp. Seal	5
	15	Dow 888	1
	16	Mobay Basilone S.L.	1
	17	Unsealed	2
	18	Dow 890 S.L.	1
	19	Dow 888 S.L.	1
	20	Crafco Silicone S.L.	1
	21	Crafco 221	1
	22	Watson Bowman WB-687	5
	23	Crafco 444	1
	24	Dow 890 S.L.	3

Joint Configurations

Based upon the joint sealants selected for this project, joint configurations were determined from manufacturer's recommendations and various state and federal agency requirements. Information was obtained from the Arizona, Georgia, and Colorado Departments of Transportation. The American Association of State Highway and Transportation Officials (AASHTO) guidelines and Federal Highway Administration (FHWA) Technical Advisory 89-04 were also used to determine joint widths.

The primary cut for all joints was specified as the thickness of the slab (T) divided by three (T/3), with a width of 1/8 inches. The width and depth of the secondary cut was established specifically for each sealant. Five joint details were formulated to receive the various joint sealants. Detail 2 was used for the two unsealed test sections. Joint details are provided in Figure 3.

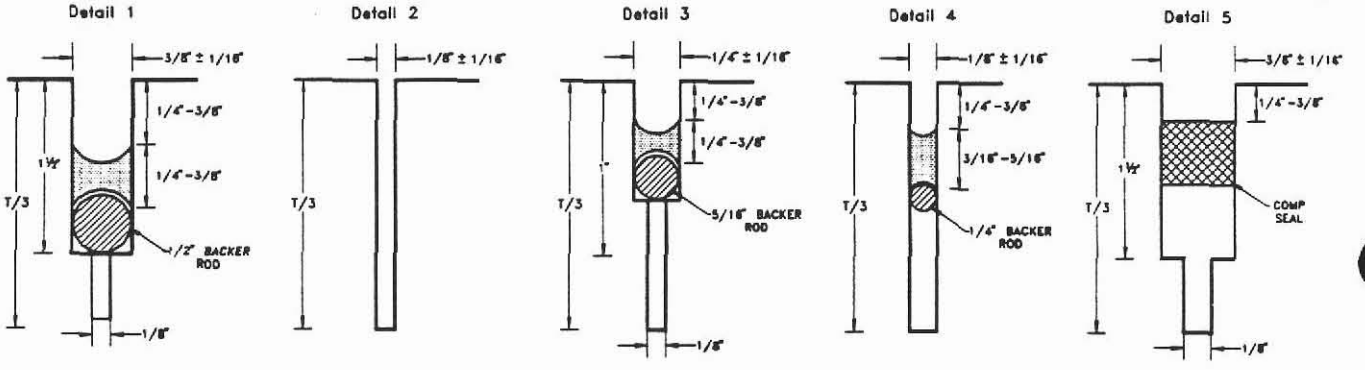

Figure 3 - Joint Details

Joint Specifications

Specifications from the Department of Transportation for the State of Georgia were reviewed, along with a specification written by Purdue University for SHRP for use in SPS-4 research projects. It was concluded that all transverse joints will be constructed in accordance with Section 401-3.06 of the 1990 ADOT Standard Specifications for Road and Bridge Construction.

This specification was used with the following additional requirements:

- The concrete shall cure a minimum of 7 days prior to sealant installation. In the event of rain, the time shall be extended an additional day for each day of rain.
- Sand blasting shall be performed in two passes (one for each joint face) with the nozzle directed at the joint face. Both passes shall be in the same direction.

- Just prior to sealant installation, the joint shall be blown out in one direction only.
- The nozzle used to install the sealant should be such that the joint is filled from the bottom up.
- Installation of the Crafco Hot Pour sealants will be performed in accordance with manufacturer's recommendations.
- Traffic will not be allowed on newly sealed joints for at least 3 days.

Except in the compression seal test sections, all joints, including both longitudinal and transverse joints will utilize the sealant indicated for that section. In the sections with compression seals, the longitudinal joints will be sealed with the sealant material currently available at the project.

All longitudinal joints will be sawn and sealed in accordance with project plans and specifications. The joint details refer only to the transverse joints.

Joint Measurements

The following joint measurements were obtained as part of the experimental plan for this research project. Since joint details varied depending on the sealant used, all of the following measurements were not necessarily obtained for each transverse joint.

- Joint location
- Joint width
- Depth (secondary cut)
- Primary joint depth
- Joint crack width
- Joint backer rod depth
- Sealant joint depth

Nondestructive testing (NDT) was conducted in accordance with SHRP Protocol: H30F Falling Weight Deflectometer Deflection Testing.

Testing was conducted using SHRP equipment at 10 transverse joint locations in each test section except for sections 5 and 22. ADOT FWD equipment was used to obtain test data at each joint for sections 5 and 22. Test data were used to develop relationships between joint evaluation criteria and pavement performance.

Changes In Experimental Plan

In the course of adopting the experimental plan to actual field construction, several changes had to be made. In March 1991, SHRP requested a 500-foot test section for testing a silicone joint

sealant. In order to fulfill this request, the first nine joints of section 3 adjacent to section 2 in experimental zone no. 1 were cut according to joint detail 1. This increased the number of joints in section No. 2 from the existing 25 to 34. These transverse joints were sealed with Crafco Silicone S.L. Section No. 3 was approximately 567 feet long and contained 38 unsealed joints.

An Elastomer PV-687 Compression Seal was initially included as one of the two compression seals to be used in the experimental plan. A Watson Bowman WB-687 compression seal was used in lieu of the Elastomer PV-687. The Watson Bowman WB-687 was to be used in Sections 5 and 22, but a Watson Bowman WB-812 was used in Section 22.

Transverse joints were sawn 3/8 inches wide instead of 1/4 inch wide by the contractor at Section No. 4. There is an "extra" joint (#26) at the end of Section No. 8 because it was not sawn to typical dimensions for this section or the next section (No. 9). It was, however, sealed with a Crafco 444 sealant. A construction joint is included as one of the experimental joints in Section Nos. 12 and 24. There is a construction joint in Section No. 18 between joints Nos. 24 and 25. This joint was not included in the experimental plan.

The final section layout, test section numbering, and sealants used are provided in Figure 4.

A 5/16-inch diameter backer rod was specified for joint detail 3. A 3/8-inch diameter backer rod replaced the 5/16-inch diameter backer rod.

The experimental plan recommended that the JPCP be cured for a minimum period of 7 days prior to sealant installation. Ideally, all sealants were to be installed in a relatively short time period after the minimum cure time was achieved. Except for the Watson Bowman compression seals, all sealants were installed between March 18 and March 31, 1991. The Watson Bowman compression seals were installed on May 7, 1991, because the Elastomer PV-687 compression seal could not be purchased in a timely manner.

CONSTRUCTION

Construction Procedures

Sawing

The plain concrete pavement for this project was placed on February 13, 1991. The contractor began sawing the 4.333-inch (T/3) deep primary cut as soon as the concrete attained an age at which extensive raveling did not occur. Primary cutting was performed on February 13, and 14, 1991. Secondary cuts were sawn on February 15, 1991. All joints were cut using riding saws (Figure 5). The various sealant reservoirs were formed after all primary transverse joints were cut for a section.

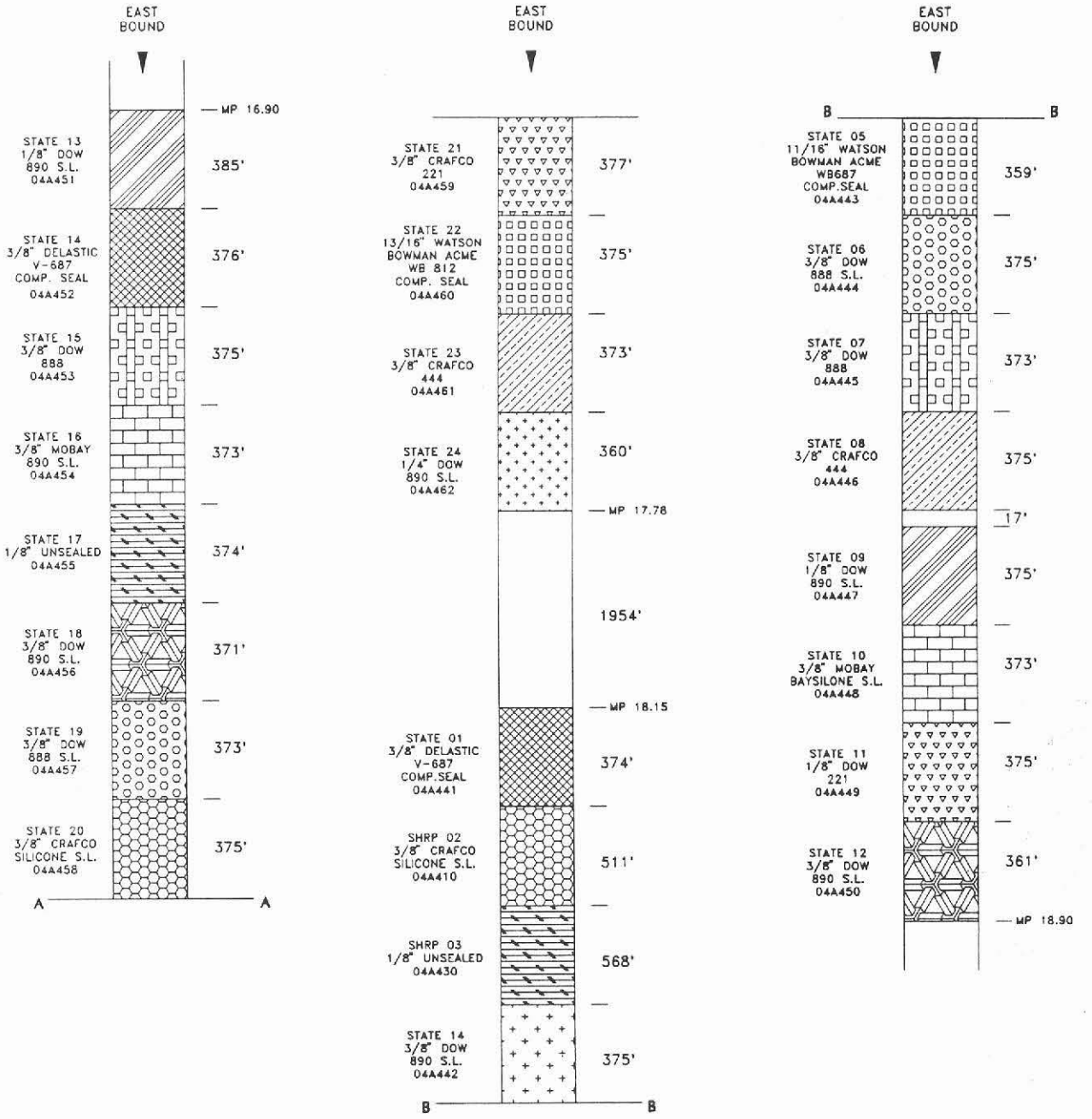

Figure 4 - Final Test Section Layout

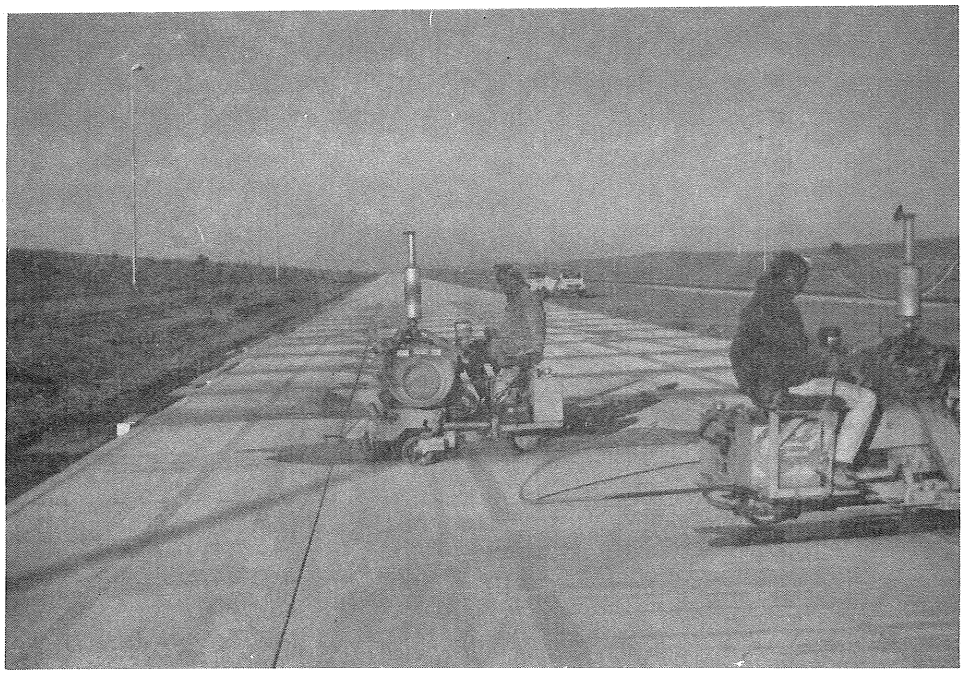

Figure 5 - Primary Saw Cutting Using Riding Saws

Joint Cleaning

After the joints were sawn, they were cleaned using air jetting methods having an air pressure of 120 psi. Air jetting did not usually remove all compressibles; therefore, the joints were dry sawn. After dry sawing, the joints were sand blasted in two passes (one pass for each joint face) with the nozzle directed at the joint face. Both passes were in the same direction. The joints were then air cleaned. Because of the accumulation of latency from the cutting operation and compressibles deposited by construction traffic, air jetting could not completely clean the joints. Therefore, water jetting was also used (Figure 6). All water from this operation was carried towards the shoulders. Approximately 1 to 1-1/2 gallons of water was used per joint. Where required, pieces of aggregate located in the joints were removed using a rock rake. Joints were again air jetted, prior to receiving sealant, using the hot pour tip.

Backer Material Placement

A backer rod was required for joint details 1, 3 and 4. Backer rods were installed after final joint cleaning and just prior to the application of the sealant. For joint detail 1, a 1/2-inch diameter closed-cell polyethylene rod was used. In joint detail 3, a 3/8-inch diameter backer rod replaced the specified 5/16-inch diameter backer rod. The contractor stated that a 5/16-inch diameter backer rod was not available. Joint detail 4 required a 1/4-inch diameter backer rod. The Contractor used backer rods produced by various manufacturers. The use of various backer rods